

## **NIST Fourth Quarter Progress Report Home Smoke Alarm Research Project**

1. Acquire test detectors/alarms and conduct detector characterization. Months 1-3

The NIST project staff will meet with smoke alarm manufacturers and develop a set of test articles that are representative of the range of products currently sold. Appropriate modifications may be made to the test articles to facilitate the acquisition of useful data but any modified articles will be calibrated against unmodified devices to assure representativeness. All test articles will be initially characterized in NIST's FE/DE apparatus to provide baseline data. Test articles exposed to fire tests will be re-checked in the FE/DE between field trials to assure that such exposure did not alter the operational characteristics.

\$95k

All planned test articles have been received. Characterization work in the FE/DE has been completed. Sample repeatability is good and analog data can be obtained without problem. Test articles exposed to fire tests are being re-checked in the FE/DE between field trials to assure that such exposure did not alter the operational characteristics.

2. Identify potential dwellings for test sites Months 1-3

Test sites must be typical of US housing and represent single- and multi-family units, apartments and condominiums, and manufactured homes. Test sites will be selected from donated homes scheduled for demolition or rehab, purchased units, or simulated arrangements of rooms. Potential sites will be identified and evaluated by NIST staff and selections made in the interest of the overall project goals.

\$25k

A donated home in Kinston, NC has been used in the completion of the two-story phase of the off-site testing. Efforts are underway to identify a ranch-style home for further off-site testing in the Winter/Spring of 2002.

3. Plan Long-Term Site at NIST

One of the test sites shall be a manufactured home to be purchased and located at the NIST site for the duration of the work. An appropriate floor plan has been chosen and a unit shall be procured and installed on the site.

The manufactured home has been delivered, installed, instrumented, and used in the first phase of on-site testing. Plans are currently being developed in order to construct a fire-hardened manufactured home replica, in cooperation with the Sublethal Toxicity Project. The replica will provide flashover testing ability and will support completion of the second phase of manufactured home testing.

#### 4. Review NFIRS data and develop scenarios

For the test scenarios to be realistic, they need to be based on current, fatal residential fire scenarios based in terms of such parameters as ignition source, room of origin, location of occupants, and time of day. Dr. John Hall of the National Fire Protection Association (NFPA) shall conduct an analysis of the latest five years of NFIRS data to develop the test scenario descriptions. This work is being conducted by NFPA as an in-kind contribution to the project.

The fire scenarios were developed based upon NFIRS analysis presented to NIST by Dr. John Hall of the NFPA. Scenarios of sufficient frequency and fatal causality were chosen for the current experimental series. Table 1 shows the five primary scenarios selected for the manufactured home series.

#### 5. Perform Modeling Studies of Sites.

Modern fire models can provide valuable insights into the development of fires in the test spaces. The NIST Fire Dynamics Simulator (FDS) shall be used to examine test arrangements and fire scenarios in advance of the experiments to provide information useful for instrument selection and location.

The heat release rate (HRR) of the upholstered furniture and mattresses were measured in order to provide input to the FDS model. Simulations assisted in planning of both the manufactured home experiments, as well as the Kinston, NC experiments.

#### 6. Develop instrumentation and test plans for sites

Months 3-6

Instrumentation layout, sensor locations, and measurement types need to be selected based on the scenarios planned and the floorplan of the site. These will be developed with the assistance of the modeling discussed in task 5 and the scenario list from task 4. \$50k

Detailed instrument and sensor locations have been completed for the manufactured home. Instrumentation for the North Carolina site has been completed. We are currently planning 25 tests in the manufactured home and 10 tests were completed in North Carolina.

#### 7. Identify and acquire fuel items

Months 3-6

The primary fuel items for the tests will be furniture and other household goods and these need to be representative of current materials and constructions. Some inexpensive items may be purchased new, but furniture items will be purchased used from residential furniture rental outlets. For the scenarios and floorplans of sites the appropriate items will be identified and procured. For field testing items will be procured locally to avoid shipping costs.

\$50k

Based on the scenarios and test plans we have purchased residential mattresses and chairs to serve as the primary fuels. The mattress is a twin size, pillow top

design that will allow for the smoldering tests. We have constructed a smoldering igniter from a nichrome wire loop on a ceramic insulator powered from a variac. This igniter was used in Australian tests in a similar fashion. Manufactured home testing shows reasonable smoldering results. Sufficient chairs and mattresses have been ordered to provide for all tests with several spares.

#### 8. Construct long term test site Months 3-6

Some testing may be conducted in an arrangement of rooms within the NIST test facility and others may be conducted in a manufactured home at the NIST site. The former needs to be constructed and the latter modified to allow fire testing without risking the unit. \$65k

The initial manufactured home and North Carolina tests have been completed. Collaboration with the Sublethal Toxicity Project will result in a fire-hardened site identical to the manufactured home but capable of withstanding multiple flashovers. This will be paid for by the other project. Funds in this task were used to cover the costs of preparing the manufactured home for the initial manufactured home tests and North Carolina tests.

#### 9. Conduct initial fire testing Months 6-12

The first round of testing for smoke alarms shall consist of two tests per day for five days with the last tests actively sprinklered or flashover tests. These tests require a crew of engineers and technicians to do preparation, conduct the tests, and clean up/tear down the instrumentation for the next series.

The first round of smoke alarm testing was completed in the manufactured home. Fifteen of the twenty-five planned tests were conducted. Table 1 identifies each of the tests completed. In addition, the first round of off-site testing was completed in the two story home configuration. Table 2 identifies each of the tests completed in Kinston, NC from the period of September 17 – 28.

#### 10. Conduct initial nuisance alarm testing Months 6-12

Development of recommendations for nuisance alarm tests will involve tests in the NIST test site in a representative geometry followed by the reproduction of exposure conditions within the FE/DE facility, with careful measurements in the former guiding the latter. The data obtained will be used to develop reproducible and repeatable testing protocols that are suitable for incorporation into US and international testing standards.

Currently the analog sensors used in Kinston are undergoing recalibration in the FE/DE to ensure that they are still operating properly. Following this initial testing against candidate nuisance alarm sources will begin (probably mid- to late November). Sources that can be shown to be reproducible will be used in the manufactured home and in the FE/DE and cross-compared.

Table 1: May/June Manufactured Home Tests

	Test 1	Test 2	Test 3	Test 4	Test 5
<b>Fuel Package</b>	Upholstered Furniture	Upholstered Furniture	Mattress	Mattress	Mattress
<b>Fire Condition</b>	Smoldering	Flaming	Smoldering	Smoldering	Flaming
<b>Location</b>	Living Room	Living Room	Bedroom	Bedroom	Bedroom

	Test 6	Test 7	Test 8	Test 9	Test 10
<b>Fuel Package</b>	Mattress	Mattress	Mattress	Mattress	Upholstered Furniture
<b>Fire Condition</b>	Smoldering	Flaming	Smoldering	Flaming	Flaming
<b>Location</b>	Bedroom	Bedroom	Bedroom	Bedroom (Door Closed)	Living Room

	Test 11	Test 12	Test 13	Test 14	Test 15
<b>Fuel Package</b>	Upholstered Furniture	Grease	Grease	Mattress	Upholstered Furniture
<b>Fire Condition</b>	Smoldering	Flaming	Flaming	Flaming	Flaming
<b>Location</b>	Living Room	Kitchen	Kitchen	Bedroom (Door Closed)	Living Room

Table 2: September Tests completed in 2 Story Home in Kinston, NC

	Test 1	Test 2	Test 3	Test 4	Test 5
<b>Fuel Package</b>	Mattress	Mattress	Mattress	Upholstered Furniture	Upholstered Furniture
<b>Fire Condition</b>	Flaming	Flaming	Smoldering	Flaming	Smoldering
<b>Location</b>	Bedroom	Bedroom (Door Closed)	Bedroom	Living Room	Living Room

	Test 6	Test 7	Test 8	Test 9	Test 10
<b>Fuel Package</b>	Grease	Upholstered Furniture	Upholstered Furniture	Upholstered Furniture	Generic Living Room Setup
<b>Fire Condition</b>	Flaming	Flaming	Flaming	Smoldering	Flaming (Flashover)
<b>Location</b>	Kitchen	Living Room	Living Room	Living Room (HVAC on)	Living Room

14. Format data and publish on the web.

Reduced data files from all testing shall be formatted into the Fire Data Management System (FDMS) and posted on the NIST web site.

Raw data from the first series of manufactured home tests has been converted to FDMS format and posted to the NIST website, along with complete documentation of the tests conducted and instrumentation utilized. The web site can be accessed at <http://smokealarm.nist.gov> . Efforts are presently underway to similarly present the data from the Kinston test series.